



NATO Code of Best Practice (COBP) for C2 Assessment

A large, light gray compass rose graphic is centered on the slide. It has four main points and four smaller points, with a circle around it. The text 'Methods and Tools' is centered over the top half of the rose, and 'Don Kroening, US' is centered over the bottom half.

Methods and Tools

Don Kroening, US

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Topics

- **The Need for Change**
- **Categories of Methods and Tools**
- **Issues with Assessing C2 Effectiveness**
- **New Methods and Emerging Practices**
- **C2 Modeling Guidelines**
- **Conclusions**
 - **Strengths**
 - **Challenges**



The Need for Change

Our methods and tools must respond to a changing world:

- Large number of scenarios required due to an uncertain future
- Increasing emphasis on command and control
- Growth of Operations Other Than War (OOTW) importance requiring new approaches
- Sense of urgency leading to need for easy to use fast turnaround tools
- Need to integrate tools for training, acquisition, and operational support.



Categories of Methods and Tools

- ***Data Collection/Generation*** - Used to collect or generate data for subsequent analysis.
- ***Data Organization/Relationship*** - Used to organize data or to establish relationships between data.
- ***“Solving”*** - Used to mathematically derive solutions to problems, even if based on subjective data.
- ***Support*** - Used to organize, store, and explore typically large sets of empirical data.

Any analytic method/tool has potential application for C2 assessments



Example Methods/Tools by Category

Category	Example Methods/Tools
Data Collection/Generation	Real Word Operations Lessons Learned, After Action Reviews/Reports, Historical Analysis, Expert Elicitation, Constructive (Force-On-Force) , Virtual (Simulators, STAFFEX, MAPEX), and Live (CPX, FTX, Advanced Warfighting Experiments) Simulations, Game Theory, Wargaming, Brainstorming, ACCESS/HEAT
Data Organization and Relationships	Causal Mapping, Multi-Criteria Decision Analysis, Regression Analysis, Factor Analysis, Neural Nets, Systemic Approaches (e.g. Systems Dynamics)
“Solving”	Mathematical Analysis, Linear Programming, Goal Programming, Integer Programming, Heuristic Searching Techniques, Genetic Algorithms, Project Management Tools
Support	Data Analysis, Geographical Information Systems, Visualization, Databases, Checklists, Spreadsheets, Planning Tools



Types of Simulation

Constructive Simulation (Simulated people operating simulated systems):

**Force-on-Force Simulations (Analytic & Training),
Specialized Models, Network Simulations (Petri-Net,
Live Analyst, OPNET)**

Virtual Simulation (Real people operating simulated systems):

MAPEX, CAMEX, STAFFEX, Simulators, DEXES/CAM

Live Simulation (Real people operating real systems):

CPX, FTX, AWE

Source(s) of definitions:

- US DoD M&S Master Plan, October 1995
- NATO M&S Master Plan, August 1998



Issues with Assessing C2 Effectiveness (1 of 2)

Issues for all C2 analysis, to include OOTW C2:

- Human behavior representation
- Homogeneous models versus hierarchies/federations
- Stochastic versus Deterministic models
- Adversarial representation
- Verification, Validation, and Accreditation of models
- Sensitivity analysis and uncertainty

These issues also addressed by SAS-017 LTSS.



Issues with Assessing C2 Effectiveness (2 of 2)

Issues particularly important for OOTW C2 analysis:

- **Selecting an orchestrated set of tools**
- **Scoping the analysis**
- **Consideration of the human dimension early**
- **Trust/confidence in tools by decision makers**



New Methods and Emerging Practices

Evaluate and select an orchestrated set of methods and tools

- Apply models effectively in a complementary way during all phases of the analysis where required
- Link methods and tools from problem formulation through problem solution
- Federate models in real time
- Link simple tools for scanning the scenario space and complex models for examination of specific points
- Link a hierarchy of models when required

Method/Tool Selection

Method/Tool Selection Criteria	
<i>Functionality-Related Criteria</i>	<i>Performance-Related Criteria</i>
<ul style="list-style-type: none"> • Resolution • Completeness/Scope • Functions Represented • Explicitness • MoM Generation Ability • VV&A 	<ul style="list-style-type: none"> • Responsiveness • Simplicity • Preparation/Use Time • Data Availability • Interoperability • Resource Requirements • Credibility



Using Models Effectively (1 of 2)

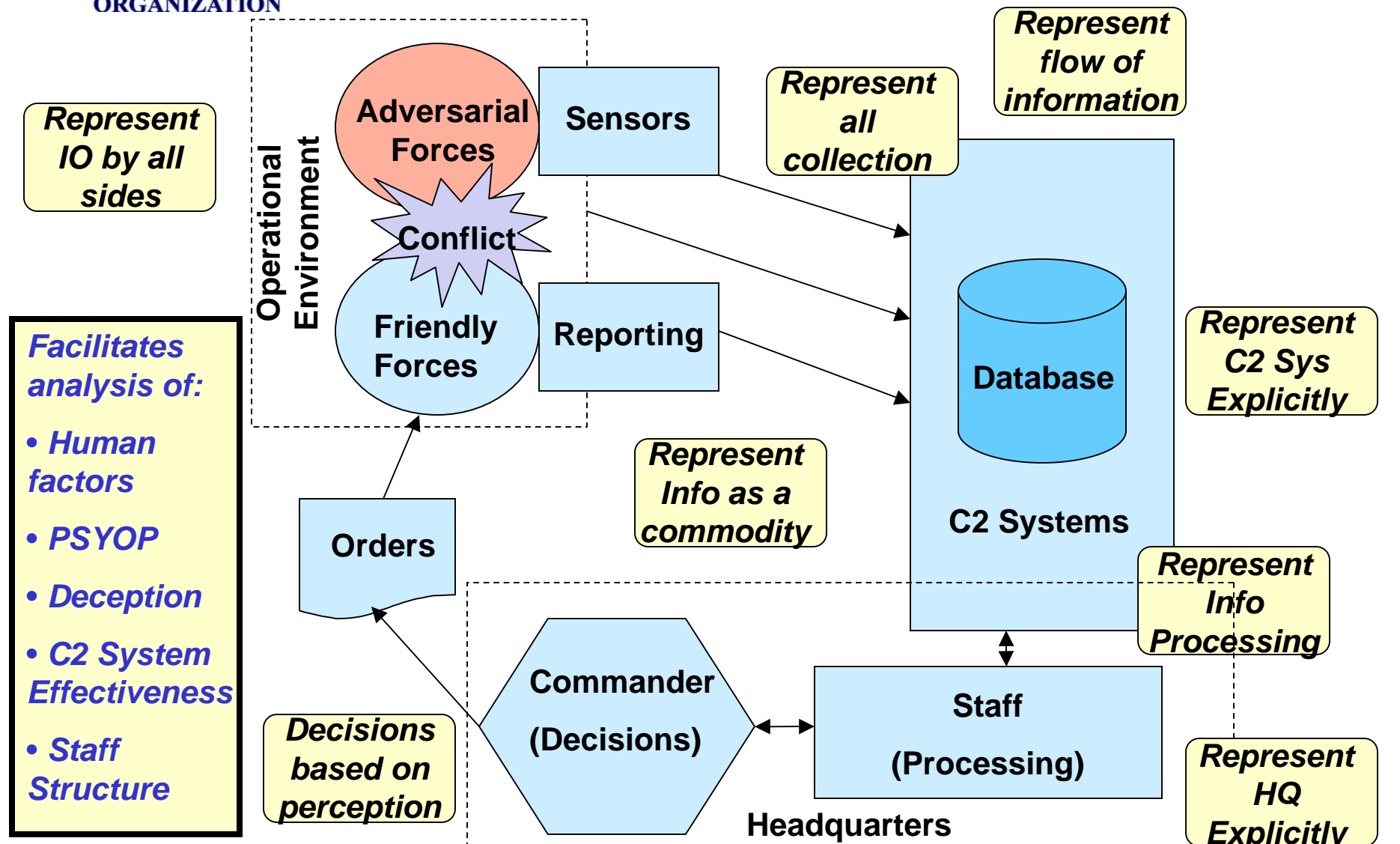
- ***Orchestrate a set of models/tools:***
 - Federate models when possible/appropriate
 - Establish a hierarchy of models (e.g. link performance models/tools to effectiveness models/tools)
- ***Select/Develop models with C2 representation:***
 - Represent C2 processes through agent modeling (either through rule sets or complexity-based approaches)
 - Represent the decision making process



Using Models Effectively (2 of 2)

- *Verify, validate, and accredit models*
 - **Verification:** Does the model represent what the developer specified?
 - **Validation:** Does the model accurately represent the real world sufficiently for intended use?
 - **Accreditation:** Is the model appropriate for its intended analytic use?
- *Generate the required data for models*
- *Apply the models effectively:*
 - **Scan the scenario space with appropriate models**
 - **Use models in a complementary way with other models/tools**

C2 Modeling Guidelines





Strengths in C2 Methods/Tools

- **Common understanding of the issues and approaches**
- **Wide application of C2 modeling**
- **Linking and federating models**
- **“Soft Factor” analysis progress**
- **Standards development**
- **Use of Commercial Off The Shelf (COTS) products**
- **Application of new information technologies**
- **Wide use of evolutionary approaches**

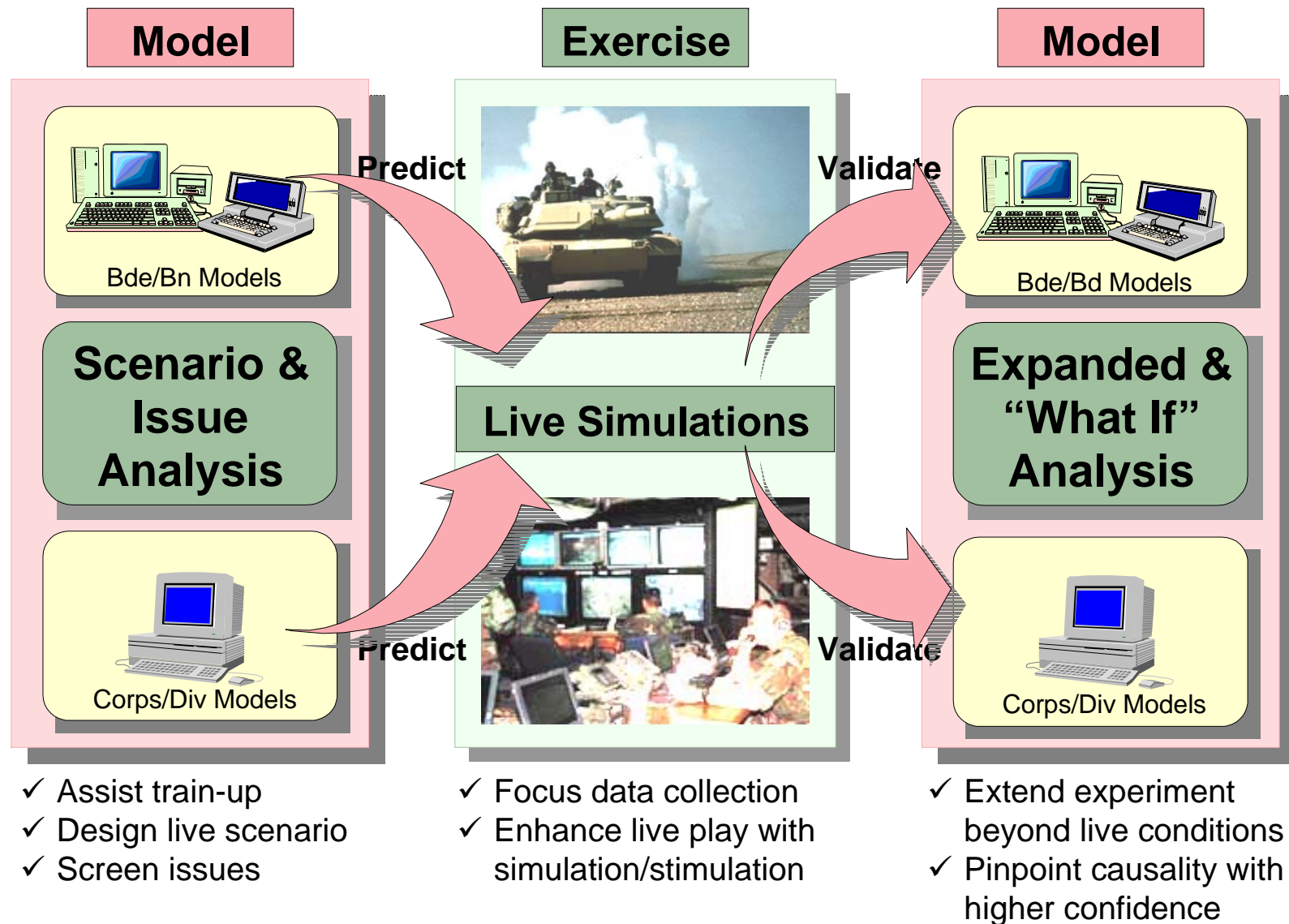


Remaining/Continuing Challenges (1 of 3)

With C2 method/tool application:

- Orchestrating a set of applicable tools
- Breadth of tool application
- Relationship of tools to data availability and MoM generation
- Sharing of tools among communities
- Management of customer expectations and relations
- Consideration of M-E-M or M-T-M.

Model - Exercise - Model (M-E-M) Approach





Remaining/Continuing Challenges (2 of 3)

With C2 modeling:

- Interaction between models, data, and measures of merit
- Better representation of cognitive processes
- Stochastic versus deterministic modeling
- C2 terminology standardization
- Scoping of C2 analysis
- Shared use by analysis, training, and operational communities



Remaining/Continuing Challenges (3 of 3)

With C2 modeling (continued):

- Standardization for shared use by analysis, training, and operational communities
- Resourcing both the breadth and depth of C2 modeling
- Similar representation of friendly and adversary forces
- Additional “soft factor” modeling
- Model Verification, Validation, and Accreditation
- Sensitivity analysis

Methods and Tools

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